

INFLUENCE OF BERSIM *TRIFOLIUM ALEXANDRINUM* L. (FABACEAE FORAGE) ON THE DEVELOPMENT OF *HETERODERA AVENAE* POPULATION WOLL., 1924 IN ALGERIA

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ABSTRACT

The study conducted over three years, from September 2009 to August 2012, on rotation (bread wheat (variety Anza)/bersim (variety Miscawi)/durum wheat (variety Vitron) in the region of Oued Smar (03°09E / 36°42'N) showed an average annual reduction of 26.1% of second stage L2 of *Heterodera avenae*. The estimated population densities in terms of number of cysts/100g of soil do not reflect this decline, because many cysts were obtained before and after crop. Otherwise, the results in L2/g of soil show a declining enrollment of this nematode just after bersim crop.

KEYWORDS: *Heterodera avenae*, Rotation, Wheat, Bersim, Algeria

INTRODUCTION

The cereal cyst nematode (CCN), *Heterodera avenae* (Woll. 1924) is widespread in temperate regions of cereal production (Rivoal and Cook, 1993; Nicol *et al.*, 2003; Smiley *et al.*, 2005). This species is present in nearly 50% of cereal crops in Europe (Rivoal and Cook, 1993), 66% north of the USA (Smiley *et al.*, 1994) and 80% in Tunisia (Namouchi-Kachouri and B'Chir, 1997).

In Algeria, since it was reported by Scotto La Massese in 1961, *H. avenae* has been recognized as a predominant species in the grain-producing areas such as Ain Defla, Batna, Béjaïa, Birtouta, Dahmouni, Oued Smar, Sétif, and Tiaret (Mokabli *et al.*, 2001).

Falling yield of wheat and barley following the attacks of *H. avenae* are reported in England (Dixon, 1969), Australia (Meagher and Brown, 1974), Slovakia (Sabova *et al.*, 1981), Germany (Sachse, 1986), Libya (Siddiqui and Khan, 1986) in France (Rivoal and Sarr, 1987), India (Dhawan and Nagesh, 1987), Pakistan (Shahina and Maqbool, 1990), Spain (Romero *et al.*, 1991), Italy (Greco *et al.*, 1993), China (Zhang *et al.*, 1994), Morocco (Rammah, 1994), Saudi Arabia (Ibrahim *et al.*, 1999) and the USA (Smiley *et al.*, 2005).

The yield losses in Morocco were around 40 to 50% (Rammah, 1994), 20 to 40% in Australia for initial densities of 2-16 larvae and eggs/g of soil (Meagher and Brown, 1974), 30 to 50% by Russia densities of 10 to 20 larvae/g of soil (Shiabova, 1982), 50% in the USA (Smiley *et al.*, 1994), from 40 to 92% in Saudi Arabia densities for 16-32 larvae and eggs/g of soil (Ibrahim *et al.*, 1999) and 20% India densities for 5 larvae/g soil (Singh *et al.*, 2009).

The management strategy of the nematode has for a goal to reduce or maintain populations under adverse economic thresholds (Holgado *et al.*, 2006). According Lacombe and Richaud (1993) and Vacher (1994), the control of

H. avenae can only be considered by cultural practices, because in practice, on account of the area occupied by grains and the generally high cost of nematicides, chemical treatments are rarely used. Therefore, the use of resistant varieties and crop rotation are the present means. In France, significant decreases of this nematode from 60 to 80% were obtained after resistant crops varieties of barley and oats (Caubel *et al.*, 1980).

In Algeria, a decrease of 30.2% of this nematode is recorded after of chickpea crops (Smaha, 2002). In the other side, no work has been undertaken on the use of bersim (*Trifolium alexandrinum*) in crop rotation to control this nematode. In addition, the forage legume is of interest to dairy farmers in Algeria for its digestibility and its high nitrogen content.

As part of this study, it is planned to study the influence of bersim in a rotation program on population dynamics of *H. avenae*.

MATERIALS AND METHODS

This experiment was conducted on a plot of 2 ha naturally infested by cysts nematode *H. avenae* in the experimental station of the Technical Institute of Field Crops (TIFC) in Oued Smar (36°42'N, 03°09'E) at an average elevation of 45 m. The soil pH is close to neutral, clay-loam type with clay content of 35% (Chadouli, 1991).

This resort is located in the vast plain of Mitidja which extends between Blida Atlas to the south and the heights of the Sahel and the Mediterranean Sea to the north. With an annual average temperature of 18°C and an annual rainfall between 600 and 900 mm for a climate application from 1300 to 1400 mm/year. This plain is located in the sub-humid Mediterranean with mild winters bioclimatic. Winter is excess water (70% of annual rainfall occurs from September to February) and the variable spring, but often in deficit (Chadouli, 1991).

Varieties Used

Varieties of cereal crops in this study are bread wheat (Anza) which is sensitive to *H. avenae* (Mokabli, personal communication) and durum wheat (Vitron), intermediate host (Smaha, 1998). Variety or bersim clover (*Trifolium alexandrinum*) used in this rotation is Miscawi. Bersim crops are widespread in the Mediterranean basin. Their introduction from Egypt to Algeria was made in 1850. Among the varieties introduced from Egypt (Fahl, Saidi and Khedrawi), only Miscawi was maintained because of its perfect acclimatization to local conditions (Chadouli, 1991). Bersim was installed in the sub-littoral zone characterized by high humidity and temperatures sufficient for its development.

Soil Sampling

The soil samples for nematode analysis, to a number of 20 samples per plot were made over three years, before setting up of wheat crop in September 2009, bersim in September 2010 and durum in September 2011. Similarly the soil sampling is made in August 2010 after the harvest of wheat in August 2011 after bersim cuts and in August 2012 after the harvest of durum wheat.

Sampling is performed on 20 rectangular sampled areas 2.40-m long by 5m wide (Rivoal, 1986) at a depth between 10 and 30 cm using an auger. The soil samples were placed in plastic bags in which the sampling date and plot number are mentioned. In the laboratory, the soil is previously dried at open air for 2 to 3 days, 1 kg is taken which extraction cysts by Fenwick the apparatus is performed.

The use of this device is based on the density of cyst nematode relative to that of water. The wet and solid cysts have a density greater than 1.08 (Nakachian and Jaquemont, 1971). In contrast, the dry cysts, whatever their content, have a density lower than 1. Solid wet cysts settle rapidly, while the dry cysts which float on the water surface, under the action of too full-time, will be dragged into a gutter to drain on a sieve of 250 microns. The refusal of the sieve is recovered using jets of water from a spray bottle on a filter paper lining a funnel carried by an Erlen-Meyer. When properly drained, the content of filter paper is placed in a Petri dish for harvesting cysts using a binocular microscope (magnification: 10x40).

Data Mining

Population densities measuring the rate of *H. avenae* multiplication is expressed by the link between the numbers of cysts/100g soil by the size of the final population (Pf) (after crop) divided by the size of the initial population (Pi) (before crop). Infestation levels (L2 second stage larvae / g soil) obtained before and after crops are calculated on the basis of the fertility of Oued Smar population which is 240 L2 per cyst evaluated by Smaha (1998) using 40 cysts on which it was carried out the larval counting on the second stage under binocular microscope (magnification: 10x40). The results of the infestation degree were subjected to analysis of variance using the software General Linear Model (GLM).

RESULTS

The results show many cysts before crop after crop (Figure 1). In the other side, the degree of infestation of the plot cultivated of wheat (variety Anza) the first year increased from 4.32 L2 / g soil before cultivation and 13.9 L2 / g soil after cultivation. This evolution of the degree of infestation is observed after plowing to prepare the establishment of cut culture, the bersim. This infestation is 49.4 L2 / g soil.

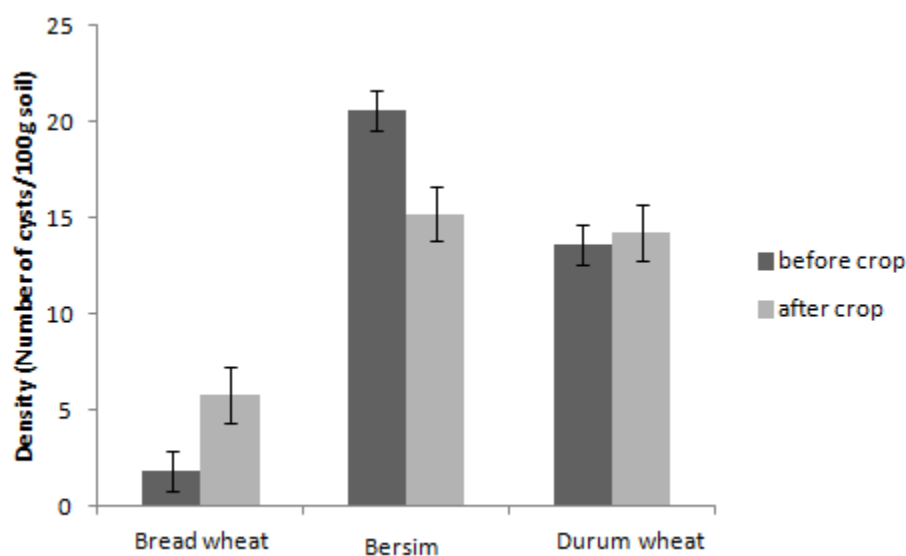


Figure 1: Average Number of *H. avenae* Cysts Identified Based on the Three Crops Studied

The degree of infestation of the plot has declined during the second year after the cultivation of wheat, since L2 is 36.5 / g of soil after harvest of bersim, a decrease of 26.1% (Figure 2). During the third year, durum wheat (variety Vitron) maintained the numbers of *H. avenae* substantially flush: the increased levels of infestation of 32.7 L2 / g of culture soil before to 34.08 L2 / g soil after harvest.

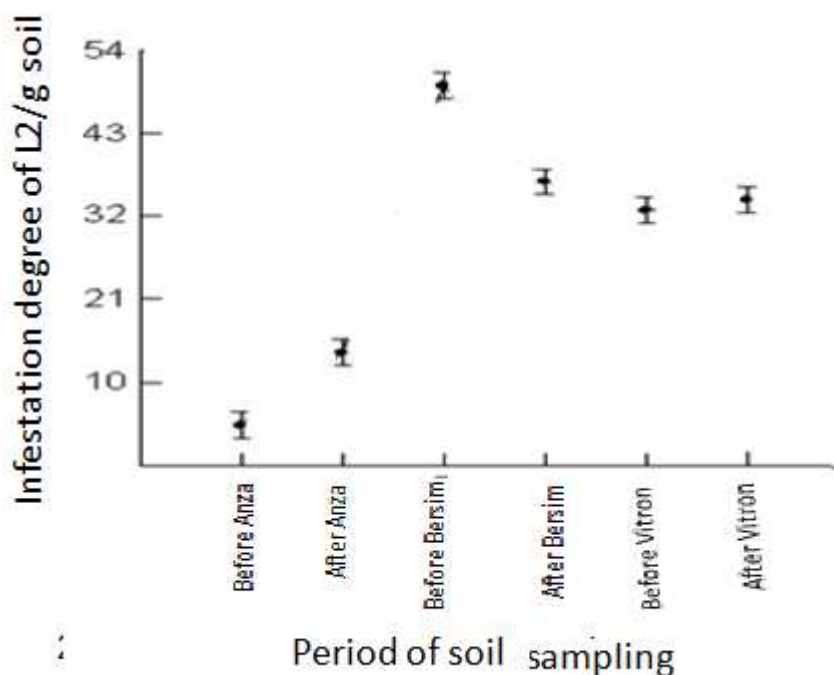


Figure 2: Fluctuations in Population Numbers of *H. avenae* Expressed in L2 Larvae/g of Soil in Three Crops Studied

Analysis of variance reveals a very highly significant difference in the degree of infestation (L2 / g of soil) with respect to the period of sampling of soil samples for the three crops: (df = 5, F = 86.922, P <0.0001).

DISCUSSIONS

The high density observed during the first year is due to wheat crop (variety Anza) which constitutes a favorable host for the development of *H. avenae*. Bersim crop caused an annual population decline, which is on average 26.1% in 2011, thus expressing a fall from 100 to 73.9%. This depressive effect exerted by crops on populations of this nematode is the destruction of the second stage larvae, which hatch cysts naturally under the influence of temperature variations and are lost due to the absence of host crops during the outbreak (Rivoal, 1982). So the introduction of bersim in cereal rotation has changed the dynamics of populations of *H. avenae*, thus limiting to some proportion multiplication.

However, this reduction is insufficient because the frequency of crop rotation bersim is performed every two years ((wheat / forage / wheat), since the following crop, the durum wheat (variety Vitron) being intermediate host, kept the populations of this nematode.

Also, levels recorded during the three years infestation remain above the acceptable threshold defined by Rivoal *et al.* (1983) and Rivoal (1986), namely 10 L2 / g of soil, since the population of *H. avenae* of Oued Smar belongs to the southern ecotype (Smaha *et al.*, 2009).

The results obtained in L2 / g of soil are more satisfactory compared to those expressed in density (number of cysts/100g floor) because they actually reveal the true state of the infestation of the plot by the populations *H. avenae* in the soil, knowing that the cysts are inert bodies and are destroyed slowly in the soil (Rivoal, 1986).

In Algeria, Smaha (2002) showed that chickpea (Fabaceae) causes an annual decrease of 30.2% of the populations of this nematode after wheat crop, Anza variety multiplier of the parasite. In Australia, the use of spices or non-host or resistant varieties has been demonstrated, since the densities of *H. avenae* can be reduced by 70-80% in a single annual crop of non-host plants other than cereals (Andersson, 1982). Similarly, the value of the annual fallow placed between two extensive wheat may limit the impact of this nematode (Eastwood, 1995). In France, a decrease of nearly 80% of *H. avenae* populations was also observed after a non-host crop in northern France, against 40% in the South (Caubel *et al.*, 1980). This difference is more closely related to the fact that the Mediterranean ecotype characterized by a quota larval output requires a period longer than the ecotype ocean more or less temperate (Rivoal and Sarr, 1987) climate culture not host.

On the other hand, Rivoal and Dedryver (1982) mentioned that it was possible to modulate *H. avenae* populations by acting on the frequency of introduction of multiplying plants in three successive years. Subsequent crop of durum wheat variety Bidi 17 presented significant differences in returns that exceeded 30 quintals / ha in plots previously planted to non multiplier cereals such as sorghum and barley variety Welam, while have not reached 15 quintals / ha after monocultures cereals.

Caubel *et al.*, 1980 noted that the probability of damage is low when grain back two years on 5 years on the same sole, while the damage is to be feared when they are grown every two years. Furthermore, it was recognized that the damage is to be feared when the frequency of grain exceeds the threshold of 50%.

CONCLUSIONS

It appears from this study that even a biennial rotation reduced significantly populations of L2 larvae of *H. avenae* in soil. It would be interesting to go for the three-year rotation bersim in order to further reduce populations. This control method is a major asset for the regularization yields and helps ensure grain production consistent with the objectives of the technical routes proposed and implemented.

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